

April 1959 - September 1959

Northeastern

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NORTHEASTERN FOREST EXPERIMENT STATION

Division of Watershed Management Research

Semi-annual Report

October 1960

GENERAL

The past 6 months have been more of the same. We managed to get some well-worked-over manuscripts in (as reported in the following pages), maintained records, and attended our share of time-consuming meetings. The Division Chief attended one, the World Forestry Congress, going by way of Coweeta, Oxford, Vicksburg, Hot Springs, Fort Collins, and points west. For the many welcomes and kindnesses from watershed researchers visited en route, he and the three boys are truly grateful.

ELKINS RESEARCH CENTER

The end of April this year marked nearly three years since the start of logging on the Fernow watersheds. Streamflow and water quality data, complete to that date, have been summarized and analyzed preparatory to publishing a station paper on the results of treatment.

Enough information has been accumulated to show some recovery in water quality on the treated watersheds. The most striking, because of the extreme treatment and greater length of period, is that on the clearcut watershed. The following table of mean turbidities and range in turbidity of routine samples clearly shows the trend (special samples taken during storm periods are not included).

Average turbidities of routine samples on clearcut watershed.

<u>Period</u>	<u>Average Turbidity</u>	<u>Range in Turbidities</u>
During logging operation (40)*	490	0 - 5000
First year following logging (86)*	38	0 - 700
Second year following logging (77)*	1	0 - 53

(*numbers in parentheses indicate the number of samples)

This table emphasizes the point that the time of greatest damage to water quality is during the logging operation and indicates that that period should be kept as short as possible for any area.

Streamflow data have been collected on each of the treated watersheds for at least one full growing season and the results fall into a logical pattern. The following table shows the increase in flow over what might be expected from an undisturbed watershed.

Comparison of predicted and measured seasonal flows
after start of treatment in the 4 logged watersheds

Watershed		Discharge for growing season (May - Oct.)			
No.	Treatment	Year	Predicted	Measured	Increase
(area inches)					
1	Commercial	1957	2.45	3.79	1.34*
	Clearcut	1958	13.18	17.53	4.35*
		1959	2.59	5.67	3.08*
2	Diameter	1958	15.09	15.79	0.70*
	Limit	1959	3.39	5.23	1.84*
5	Extensive	1958	17.52	18.15	0.63
	Selection	1959	4.22	5.64	1.42*
3	Intensive Selection	1959	3.41	3.72	0.31

* Increase is statistically significant at the 5% level.

Significant increases were obtained on the two watersheds which received the more severe treatments even before they were completely cut; i.e. Watershed 1, in 1957 and Watershed 2 in 1958. Although the increase in flow in Watershed 3, the most lightly cut, was not significant, it falls into a logical pattern when considered in relation to the amount of timber cut and deadened.

Increase in streamflow in relation to
volume cut and killed on Fernow watersheds

1959 growing season			
No.	Watershed : Treatment	Increase in flow (area inches)	Volume cut & culled (feet BM/Acre)
1	Commercial Clearcut	3.08	9,000
2	Diameter Limit	1.84	4,300
5	Extensive Selection	1.42	3,500
3	Intensive Selection	0.31	1,800

The 1959 growing season was the first full growing season after treatment for the diameter limit, and two selection watersheds; it was the second for the clearcut watershed. How much of the flattening of the curve of increase over volume cut is due to regrowth on the clearcut watershed in tree sprouts and herbaceous plants is not known, but it seems reasonable to assume that there has been some.

The problem of finding a suitable parameter to be used in analyzing the effect of watershed treatment on high flows has taken quite a bit of time and thought. Peak flow, the instantaneous maximum rate of flow of a storm, is an obvious candidate, but it is influenced by such a number of factors that its usefulness in analysis is limited. Two estimates of storm flow volumes appear to be much more promising. The total flow above an arbitrary rate (we have used 5, 10 and 15 csm) gives comparable data for treated and control watersheds which synthesize the effects of watershed condition and reduces variation caused by differences in timing and intensity of rainfall of different storms. A rather arbitrary method of estimating the total flow during a storm occurrence has also shown promise as a parameter in these analyses. The total flow from the beginning of storm runoff to a point where the hydrograph returns to a rate of flow midway between the peak and beginning rates is used. This is an objective way of getting a volume figure usable in analysis.

Analyses are also being made of the change in flow by several classes of rate of discharge.

Ken Reinhart has used much of the data and analyses, which will be included in the Station Paper, to prepare a paper for presentation at a joint SCS-ARS-FS workshop to be held in New Orleans in October.

In the last semi-annual report we mentioned the lack of homogeneity of variance on our watersheds in the calibration and treatment periods. Henry Anderson and Jake Kovner came through with some interesting and helpful suggestions for analysis in this case.

The flow of visitors--foreign and domestic--who have come to see the Fernow watersheds has continued over the past six months. The exchange of information has not all been one way--we have gained a lot from our discussions with these men.

A total of 280 domestic visitors in 27 different groups spent some time with us during the past 6 months. These included the following work conferences held here:

1. Region 7 watershed training session.
2. Eastern U. S. watershed work conference.
3. Eastern U. S. Soil Conservation Service forestry training session.
4. Joint silvicultural work session of the following Experiment Stations: Central - Northeastern - Southeastern.
5. Joint stand improvement training session involving Region 7 and the Northeastern Station.

Forestry student groups from the University of West Virginia and from the New York State College of Forestry visited the Fernow during this period.

LACONIA RESEARCH CENTER

Humus and Frost Study

For the past three years, measurements of humus type and depth; and frost type, depth, and incidence have been made in a northern hardwood forest having a hump-hummock micro-topography. This terrain, created by wind-thrown trees over hundreds of years, is characteristic of many areas in the White Mountains.

During each winter about 75 points were visited each week (for about 12 weeks). Snow cover was measured and the presence or absence of soil frost was determined. If present, the depth of the frost was measured and the type of frost (either permeable or impermeable) noted. The occurrence of frost proved to be relatively low. During the three winters, about 3,000 points were visited--113 of these had impermeable or concrete frost (about 5 percent).

The following summer, the same points were revisited and the humus depth and type were recorded. Each point was classified according to its micro-topographic position. Mor humus was most often encountered (67 percent of the points had more humus) with mull types (19 percent) and duff mull types (9 percent) next. About 5 percent of the points had incipient humus or none.

The table below shows the pattern of concrete frost under the different humus types:

	HUMUS TYPE			
	Mor	Mull	Duff	Incipient (or none)
<u>Within each humus type</u>				
Percent of points <u>with</u> concrete frost	5	13	5	70
Percent of points <u>without</u> concrete frost	95	87	95	30
<u>Ave. depth of concrete frost (inches)</u>	1.5	2.5	2.3	3.3
<u>Ave. depth of organic layers L + F + H and/or A, (inches)</u>				
Points <u>with</u> concrete frost	1.8	1.0	2.1	0.1
Points <u>without</u> concrete frost	3.1	2.5	3.4	0.6

Mor and duff mull humus types very seldom had concrete frost. On the other hand, the points having incipient or no humus froze quite frequently (this humus type usually was found on young mounds). Thus it appears that the newly-formed mounds, void of vegetation and surface humus, are most susceptible to freezing. A comparison of the depth of the L and F layers with the occurrence of concrete frost indicated that as little as 0.2 inches of organic matter is beneficial in reducing the occurrence of concrete frost to less than 20 percent. Regressions of depths of various organic layers upon depth of concrete frost showed surprisingly weak correlations.

We found that the snow above a point with concrete frost was less than the average snow depth 87 percent of the time, but the difference was only about 2 inches. A wide range in snow depths was involved over an entire winter--from one inch to 40 inches. Two additional inches of snow would be more beneficial in early winter than in later winter to retard rapid heat loss from the soil and thereby lessen soil freezing.

Precipitation Gages

We have found from weekly measurements over a three-year period in our precipitation gage study that tilting the gage orifice parallel to the land slope does not increase gage catch significantly on our southwest-facing watersheds.

Indications are that Alter windshields do not appreciably increase our precipitation gage measurements during periods of rainfall. However, shielded gages had a 5 percent higher catch than non-shielded gages during periods of snowfall.

Contour Model

We have just completed a three-dimensional contour model of part of our Hubbard Brook watershed. The model was made from sheets of styrofoam (12" x 36" x 1/2", available from Tufflite Plastics, Inc., Ballston Spa, New York). The sheets were cut to the desired contours (100-foot intervals = thickness of one sheet) with a scalpel. Both horizontal and vertical scales were the same--24 inches = 1 mile. The sheets were glued with a cement (obtained from same agency) one on top of the other to get a rough model. The stair step effect was eliminated by filling with plaster of paris.

Surficial details such as roads, watershed boundaries, streams, precipitation gages, etc. were outlined with pins stuck in the styrofoam. After the plaster was added the pins were removed and the desired features painted on the surface.

The advantages of this construction are its light weight and ease in cutting and joining the sheets. The filling-in with plaster of paris is as laborious as ever.

Trash Screens

A self-sinking trash screen has been devised which will restrict clogging of V-notch weirs by leaves during low flow and sink to the bottom of the weir during high flow.

The screen is constructed of 1/2-inch hardware cloth formed over a framework of 1/4-inch metal rods. The screen is open at the bottom and side next to the notch. Two one-gallon cans serving as floats are fastened firmly to the screen. Cords tied to the screen and the bottom of the weir below the V-notch keep the screen against the notch. By adjusting the length of these cords the floats can be restricted from rising above a given head. Water in excess of this head will pour in holes in the top of the cans and cause the screen to sink out of way of the notch.

NEW LISBON RESEARCH CENTER

Soil Moisture Study

The study of soil moisture in the Pine Barrens has been continued for the second of the 3-year course of observations. This year, treatments were made to two of the pine plots and two of the logged-off plots. The pine on one plot was pruned to allow 40 percent of the live crown to remain. Thus, about 60 percent of the transpiring leaf surface was removed from the plot. On the other plot, the pine basal area was reduced to half of that on the control plot.

One of the logged-off plots was deadened completely with applications of Telvar A and Ammate. The ground cover on the other plot was kept clipped to about 4 to 6 inches in height, while the blueberry and sedge ground cover on the control was allowed to grow at will.

Observations of soil moisture were taken at specified intervals, but this analysis is not complete.

Last year's bulk density measurements have been analyzed, however, and with some apparently interesting results. Bulk density is directly and highly related to percent of gravel and to depth below the surface. The equations estimated bulk density quite accurately except in the logged-off plots. Here, bulk density is related only to percent of gravel and the estimates are much poorer. Some of the highest bulk densities are in the top foot of soil--which leads us to believe that logging activity compacted the soil and increased the bulk density. This is rather unexpected in the very light soils in the Pine Barrens.

We have just about given up on the Johnson nuclear soil moisture meter. In trials reported in the previous semi-annual report, the meter worked well; but after all access tubes were installed in our soil moisture plots, it failed in its first series of measurements. At that time, temperature sensitivity seemed to be the trouble, but later it became completely inoperative. It was returned to William B. Johnson and Associates, but after many expensive hours of treatment, they finally gave it up as a bad job. Our final hope is that Dr. Newton Underwood, professor of physics at North Carolina State College, may agree to try to get it to operate. We now learn that Dr. Underwood was the actual designer and builder.

Walt Broadfoot of the Southern Station received several years of good service from a similar instrument, and we cannot understand why our meter cannot be made operable.

Work Plans

In a concentrated operation, Howard Lull and Irv Reigner wrote work plans for our three newest cooperative watershed projects. The Newark, N. J., and the Baltimore, Maryland, work plans have been approved as written. The Leading Ridge project work plan was co-authored by Bill Sopper and Dick Byrnes of The Penn State University faculty.

Single-Watershed Calibration

This is still our major activity, although it has moved into its final stage. During the semi-annual period, a description of the analysis was prepared for the No. 4 Dilldown Report, which is now being edited. A manuscript on the subject has been prepared for the Journal of Geophysical Research and has been reviewed by the Station's watershed researchers and statisticians. Certain revisions were required to render it statistically acceptable, and we now feel that outside reviewers will have no objection to the methods involved.

Reigner is now engaged in the task of putting all the data together in a longer manuscript for a Station Paper.

Another paper using the calibration concepts and data has been prepared for presentation at the ARS-SCS-FS workshop in New Orleans. It is entitled, "The Disposition of Precipitation in an Experimental Watershed."

Cooperation

In addition to the routine visits to our various cooperative projects, we were called in by several other organizations for advice and consultation.

An old friend, Harvey Frantz, called on us for information on weirs. Bud is now Executive Secretary of the Bethlehem (Pa.) Water Authority and wants to measure the natural seepage from the Authority's new reservoir.

Paul Felton, formerly with the Pennsylvania Department of Forests and Waters and now Executive Director of the Wissahickon Valley Watershed Association, called on us for ideas on possible research and for information on streamflow measurement. Reigner spent a day with Paul, looking over his problem area.

PUBLICATIONS

A simple filter for small streams. K. G. Reinhart. Northeast. Forest Expt. Sta. Note No. 107, 4 pp., 1960.

Manuscripts Submitted

Management for water production on municipal watersheds.
Howard W. Lull.

Net precipitation in a northern hardwood forest.
Raymond E. Leonard.

Forest and water research project, Delaware-Lehigh Experimental Forest, Report No. 4. Irvin C. Reigner, W. E. McQuilkin and E. F. McNamara.

Stream-gaging stations for research on small watersheds.
K. G. Reinhart and R. S. Pierce.

Plant ecology and silviculture (as they affect plant-soil water relations). Howard W. Lull.

Prediction of runoff for single-watershed calibration.
Irvin C. Reigner.